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13. ABSTRACT

The report describes a method for evaluation of bridge operational and functional performance characteristics. Identifies supporting tests, facilities, and equipment required. Provides procedures for site selection, assembly, disassembly, launching, retrieving, static load, dynamic load, mobility, and anchorage system tests. Applicable to highway, railway, floating, mobile, panel, and suspension type bridges for vehicular and foot traffic to include accessory equipment inherent to the bridge mission.

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Assault Bridge						
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U.S. ARMY TEST AND EVALUATION COMMAND
SYSTEM ENGINEERING TEST OPERATIONS PROCEDURE

AMSTE-RP-702-108
*Test Operations Procedure 9-2-027 23 February 1972

BRIDGES AND EQUIPMENT

SECTION I
GENERAL

1. Purpose and Scope. This TOP describes test procedures for evaluating the operational and performance characteristics of bridges and equipment. Equipment covered includes: highway, railway, floating, mobile, panel, and suspension types for both vehicular and foot traffic; accessory equipment includes reinforcing kits, semipermanent anchorage systems, and transport provisions where they are inherent to the mission of the bridge. For mobile bridges, with integral transport and erection vehicles, this procedure covers tests applicable to the bridge components and other procedures are referenced for the vehicular components. This procedure does not cover the fixed piers or abutments of fixed bridges that must be designed to suit local conditions, but may cover portable pier kits. From the tests listed in Section II, the test director can select those that will satisfy the requirements for the particular test item and the particular test type (i.e., engineering test, initial production test, etc.). This document provides

*This TOP supersedes MTP 9-2-030 (26 Jun 70), including all changes.

for simulated environmental testing but does not include service testing or environmental testing at climatic test sites.

2. Background. Bridges (fixed or floating) are used to support troops and equipment in movements from ship to shore, across inland waterways and across natural discontinuities of terrain such as canyons and crevasses. The ability to erect bridges and to cross obstacles rapidly is of strategic importance to the Army. The type of bridge used is dependent upon geographical location and load carrying requirements. Common types of bridges include floating, semi-permanent highway, prefabricated railroad, panel and non-standard, each having unique substructure and superstructure requirements. New and modified types of bridges and equipment are constantly being developed to meet the changing tactical requirements of the modern Army.

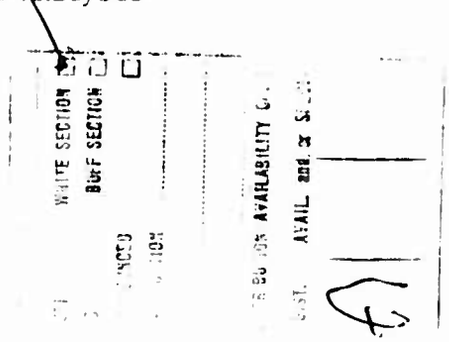
3. Equipment and Facilities. In addition to the equipment and facilities defined in the documents listed in Section II, transits, levels, variable resistance transducers (strain gauges) are required to support the procedures described in Section III.

SECTION II
TEST PROCEDURES

4. Supporting Tests. Common Engineering MTPs/TOPs, Military Standards, the tests defined in Section III, and other published documents to be considered in formulating a test plan are as follows:

	TEST SUBJECT TITLE	PUBLICATION NO.
a.	Pre-operational Inspection	10-3-500
	(1) Operator Training and Familiarization	10-2-501
	(2) Photographic Coverage	7-3-519
	(3) Site Selection (Refer to para 5)	
b.	Physical Characteristics	10-2-500
	(1) Magnetic Particle Test	MIL-STD-271D Para 4
	(2) Liquid Penetrant	Para 5
	(3) Hose Impulse Fatigue (Assault Bridge)	MIL-B-52088C Para 4.5.2.2
	(4) Hose Assembly Proof Pressure (Assault Bridge)	Para 4.5.2.3
c.	Safety	10-2-508
d.	Bridge Performance Tests	
	(1) Hydraulic Rigid Plumbing (Assault)	MIL-B-52088C Para 4.5.2.4

	TEST SUBJECT TITLE	PUBLICATION NO.
(2)	Assembly and Hydraulic System (Assault)	MIL-B-52088C Para 4.5.2.5
(3)	Assembly and Disassembly (Fixed and Floating--Refer to para 6)	
(4)	Launching and Retrieving (Refer to para 7)	
(5)	Static Load (All--Refer to para 8)	
(6)	Dynamic Load (All--Refer to para 9)	
(7)	Mobility (Fixed and Floating--Refer to para 10)	
e.	Supporting Equipment (Only when required)	
(1)	Barges, Boats and Pontons	9-2-251
(2)	Pneumatic Tools-Compressor Equipment	9-2-169
(3)	Transporter (floating)	MIL-B-52355B Para 4.6.2
(4)	Vehicle (Assault)	2-2-500
(5)	Anchorage Systems (Refer to para 11)	
f.	Environmental Testing. (By components)	
(1)	Temperature	MIL-STD-810B and AR 70-38
(2)	Sunshine	4-2-826
(3)	Rain	2-2-815
(4)	Salt Fog	MIL-STD-810B Method 509
(5)	Vibration	4-2-804
(6)	Shock	MIL-STD-810B Method 516.1
g.	Transportability	10-2-503 MIL-STD-794B
h.	Human Factors Evaluation	10-2-505
i.	Reliability Confidence Intervals and Sample Size	AMCP 702-3 3-1-002
j.	Durability (Endurance Testing)	10-2-502
k.	Maintenance Evaluation	10-2-507
l.	Value Analysis	USAMC SUPPL 1 to AR 11-26



SECTION III
SUPPLEMENTARY INSTRUCTIONS

5. Site Selection. Selection of the bridge erection site is dependent on the type of bridge to be tested and on the prescribed requirements for erection, launching or retrieving. The site is studied to determine appropriate soil conditions, bank heights and slopes, water depth, current, crossing span, traffic accessibility, maneuvering and working areas at each end, and suitable anchorage and abutment areas. Requirements and manuals are consulted for bridge applications and limitations. Access areas must be adequate for required construction equipment and test support vehicles. The test site is identified and described by photographs, soundings and instrumented measurements as to terrain and geographic/geologic features.

6. Assembly and Disassembly. (Fixed or floating bridge.)

a. Objective.

(1) To determine if the test item conforms to dimensional requirements of the procurement document or MN when erected.

(2) To determine the adequacy of assembly and disassembly.

b. Method. The test item is assembled and installed on previously prepared supporting foundation using the number of personnel, equipment and procedures described in applicable technical manuals. Comments are documented on the accuracy of fit, alinement of structural members, security of attachment to supporting foundations or pontons and interchangeability of parts. The test item is disassembled and reassembled using varying numbers and types of personnel. The time required for each assembly and disassembly is recorded for each personnel configuration used. Floating bridges, pontons or bays are captured after launch and held in place by bridge erection boats in the required ratio of bays to boats. Semipermanent anchorage systems are used when stream conditions or other emplacement conditions so justify. Time trials are conducted (a minimum of 3 for each configuration or operation) to determine times required to emplace and attach sections for stillwater and for selected varying current conditions. Attachment time is measured from the point when the boat first contacts the floating bay until permanent attachment to a mating bay is completed. Time from initial launch to assembly of total crossing span is determined. Current conditions are up to 8 fps velocity, or as limited by the governing directives, in increments, of 2 fps. Time for assembly of anchorage systems, if used, are recorded. Proper functioning of all latching and attachment provisions are determined. For integrally attached amphibious bridge vehicles, procedures are similar to those for floating bridges, except boats and anchorage systems are not

required. In planning tests for the conveying vehicles, see paragraph 4e above.

c. Data Required.

(1) Test item nomenclature and physical dimensions.

(2) Degree of misfit, nonalinement of members, insecurity of attachment to supporting structures and inadequacies of parts interchangeability.

(3) Number of personnel used in each operation with corresponding times to assemble and disassemble.

(4) Support equipment used for each operation.

d. Analytical Plan.

(1) A chart or graph is prepared showing configuration of personnel and support equipment versus times for assembly and disassembly.

(2) The effect of misfit, nonalinement, insecurity of attachment and inadequacies of parts interchangeability on assembly and disassembly operations is analyzed.

(3) The adequacy of the test item to meet the assembly and disassembly performance standards stated in the MN is determined from the above analysis (d.(1) and (2)).

7. Launching and Retrieving. (This subtest is written for a sectional type floating bridge where a single bay is carried by a special handling transporter. The procedures are modified to suit other types.)

a. Objective. To determine ability of the bridge bay to be launched and retrieved in timely manner and to determine time and manpower requirements to launch and retrieve bridge elements under various bank conditions and water elevations.

b. Method. Within limitations imposed by conditions existing at the test sites, a minimum of 3 sites of varying bank conditions are selected. Sites should represent ideal, moderate difficulty, and extreme difficulty conditions. Site selection should provide for both gravity and power assisted launch where the transporter is so designed. Time trials are conducted for both launching and retrieving operations in accordance with prescribed manual instructions. Launch time begins when the transporter is in final position for launch and terminates when the element is free floating. Retrieve time begins when the

retrieving cables are attached and terminates when the element is on the transporter tied down and ready for travel. The minimum crew required for launch and retrieve operations is determined. Proper functioning of all folding, latching and attachment devices are demonstrated. Adequacy of transporter rollers, guides, cables, fairleads, winching and attaching devices are also determined. Special requirements for positioning or handling of ramp bays are noted.

c. Data Required.

(1) Nomenclature and type of test item.

(2) Site description (bank slope, height above water, soil type and conditions).

(3) Distances from bank edge to centerline of transporter rear wheels or to point of minimum water depth for free floating elements.

(4) Conditions of visibility and weather.

(5) Crew size and individual duties.

(6) Times for preparatory operations, launch and retrieval.

(7) Comments by trained test personnel concerning:

(a) Efficiency of operation including ability of ramp or end bays to provide smooth and satisfactory traffic approaches.

(b) Results and problems of launch and retrieval operations.

d. Analytical Plan. Time and performance requirements are calculated and analyzed for each crew size, bank and water condition, using arithmetic averages for the measured trials under each condition. Performance and functional data are compared against the governing criteria. Results are presented in tabular and narrative summary, and the degree of acceptance determined.

8. Static Load Test. (All)

a. Objective. To determine the capability of the test item to withstand the static loads prescribed in the MN.

b. Method. Strain gage transducers, connected to suitable monitoring devices, are affixed to selected load bearing members of the

test item in accordance with the design stress analysis diagram and Marks Mechanical Engineers Handbook (appendix). Initially the test item is subjected to an equivalent rated load carrying capacity for a period of 30 minutes. The load on the test item is then increased to one and one-half times the equivalent rated load carrying capacity for a period of 30 minutes. The load is then removed from the test item. Stress measurements are recorded during the 30 minute test periods at rated load, at one and one-half times rated load and after removal of load.

c. Data Required.

(1) Recording of initial prestress.

(2) Weight of load at 100% and 150% of rated capacity.

(3) Recording of stress measurements during 30 minute test periods at 100%, 150% of rated capacity and after removal of the load.

(4) Vertical deflection of bridge or critical members.

(5) Recorded coverage values of temperature, wind speed and direction for each test period.

d. Analytical Plan. Stress analysis diagrams are prepared from computations of recorded data and the factor of safety of members computed when applicable. These are compared with the design stress analysis diagram and requirements of the MN to determine if stress measured is less than allowable strength of members.

9. Dynamic Load Test. (All)

a. Objective. To determine the capability of the test item to withstand the dynamic loads prescribed in the MN.

b. Method. In the performance of this test, a minimum of 25% of daily vehicular crossings is made under each of the conditions described in performance criteria. The test item is instrumented by affixing strain gage transducers, connected to suitable monitoring devices, to selected load bearing members in accordance with the design stress analysis diagram and Marks Mechanical Engineers Handbook (appendix). The test load will consist of wheeled and tracked vehicles or railroad cars, as applicable, adjusted to the rated load (military class) carrying capabilities of the test item. Initially vehicles are driven over the test item at the maximum required speed at designed vehicle spacing. Next, the vehicles or railcars are driven over the first half of the test item at posted speed, brought to a full stop at the center, and then accelerated to posted speed. Additional crossings

are made under normal risk and caution conditions with military load class being increased correspondingly.

c. Data Required.

(1) Nomenclature and physical dimensions of test item.

(2) Location of strain gages and initial prestress recordings.

(3) Type, weight and military load class of vehicles used and speed driven.

(4) Number of crossings, vehicle spacing during crossings and conditions of test.

(5) Recordings of stress measurements for each test.

(6) Recordings of stress measurements after test with vehicles removed.

(7) Recorded average values of temperature, wind speed and direction for each test run.

(8) Visual inspection to determine any deficiencies or deformations to test item resulting from testing.

d. Analytical Plan. Refer to paragraph 8.d.

10. Mobility Test. (Fixed and Floating)

a. Objective. To determine the degree of mobility attainable in the emplacement, recovery and movement of fixed and floating bridges.

b. Method. Sites suitable for the emplacement of fixed and floating bridges and separated by reasonable distances are selected for this test. The operational unit is alerted and directed to emplace the test item at the selected site. This operation is timed from the time of alert until complete emplacement of the test item with the travel distance and time recorded separately. Upon completion of emplacement, the test item is subjected to the dynamic load test of paragraph 9. After testing, the operational unit is alerted to recover the test item and transfer it to another site. This operation is timed from time of alert until recovery and from recovery to emplacement of new site with travel distance and time recorded separately. The emplacement and recovery operations are repeated as required with each emplacement followed by a dynamic load test.

c. Data Required.

(1) Time for alert to emplacement of bridge, less travel time.

(2) Time from alert (after emplacement) to recovery of bridge.

(3) Time from recovery to emplacement of bridge at new site less travel time.

(4) Travel distances and time.

(5) Success or failure of dynamic load tests performed.

(6) Number of times and places bridging operations performed.

(7) Number of emplacement or recovery failures during total testing.

d. Analytical Plan. A table or graph is prepared showing the times for emplacement, recovery and travel. This data is analyzed and compared with the requirements of the MN to determine degree of conformance.

11. Anchorage Systems. FM 5-34 (appendix) is studied to determine pertinent factors of the anchoring system. The system is instrumented with strain gages and dynamometers at critical stress points. Forces on anchorage lines and cables are observed and recorded every 15 minutes during normal crossing operations and continuously during risk crossings.

Recommended changes to this publication should be forwarded to Commanding General, U.S. Army Test and Evaluation Command, ATTN: AMSTE-PA-M, Aberdeen Proving Ground, Maryland 21005. Technical information related to this publication may be obtained from the preparing activity, Commanding Officer, Aberdeen Proving Ground, ATTN: STEAP-MT-DM, Aberdeen Proving Ground, Maryland 21005. Additional copies of this document are available from the Defense Documentation Center, Cameron Station, Alexandria, Virginia 22314. This document is identified by the accession number (AD No.) printed on the first page.

APPENDIX
REFERENCES

1. AR 70-38, "Research, Development, Test, and Evaluation of Materiel for Extreme Climatic Conditions."

2. AMCP 702-3, "Quality Assurance - Reliability Handbook."

3. USAMC Supplement 1 to AR 11-26, "Value Engineering."

4. FM 5-34, "Engineer Field Data."

5. MIL-STD-271D, "Nondestructive Testing Requirements for Metals."

6. MIL-STD-794B, "Parts and Equipment, Procedures for Packaging and Packing of", including notices 1 and 2.

7. MIL-STD-810B, "Environmental Test Methods", including changes 1 thru 4.

8. MIL-B-52088C, "Bridge, Amored-Vehicle-Launched, Scissoring-Type: Class 60; Aluminum; 60-Foot Span", including amendment 1.

9. MIL-B-52355B, "Bridge-Ferry Superstructure Transporter: For Mobile Floating Assault Bridge-Ferry Unit."

10. Theodore Baumeister, "Marks Mechanical Engineer's Handbook", McGraw-Hill 7th Edition.